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US 3979154A
DE 2657860A
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(54) Rail Wheel and Rail System Equipped with Resonance Absorbers

(57) To reduce ripple formation on a rail surface a plurality of resonance absorbers (11, 13) tuned to the characteristic frequency of the fundamental radial oscillation of a rail wheel (5) are attached to the rail (1) and/or the wheel (5). Each absorber has one or more tongues (16) capable of resonance held in contact with damping material e.g. silicon rubber. Additional tongues (17, 18) can be provided which are tuned to the characteristic frequency for the screeching and running noises.

Fig.1

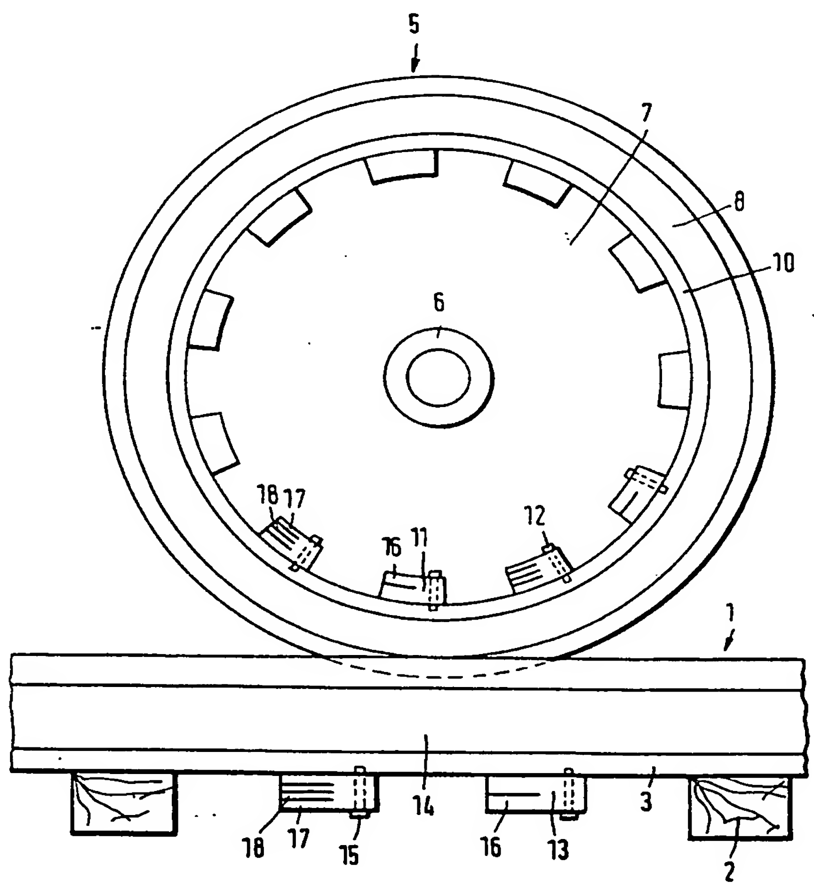


Fig.1

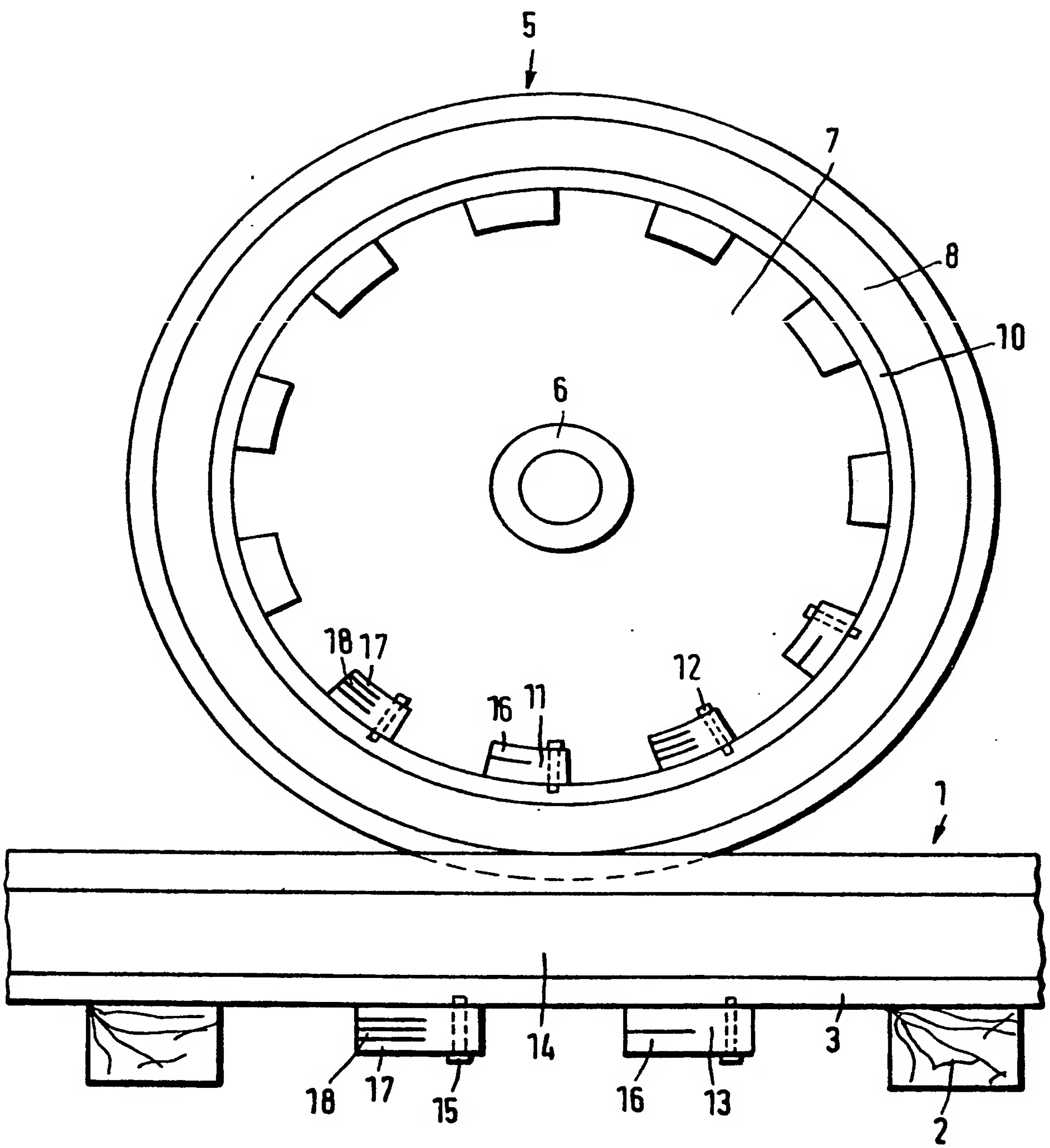
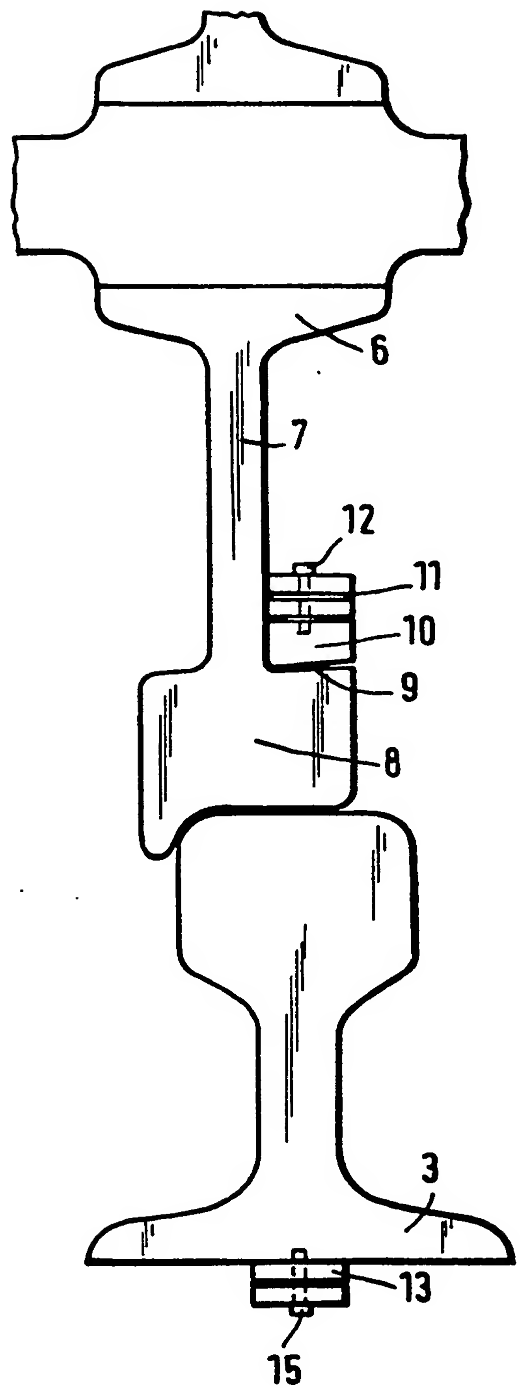


Fig.2



Fi g.3

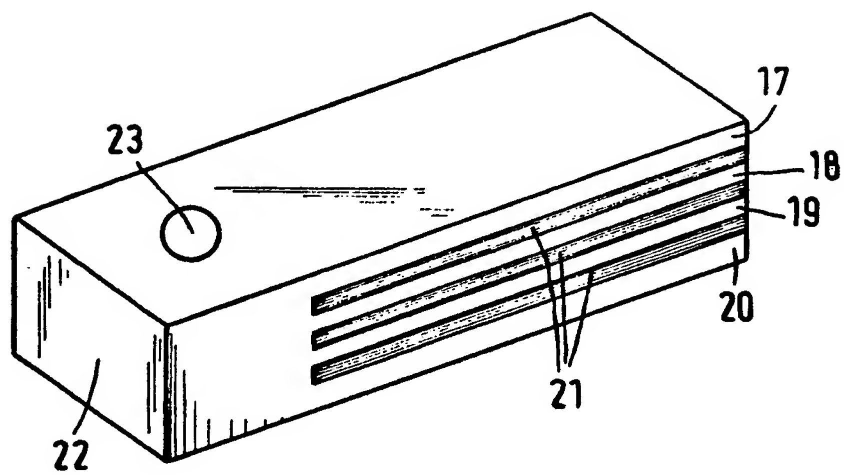
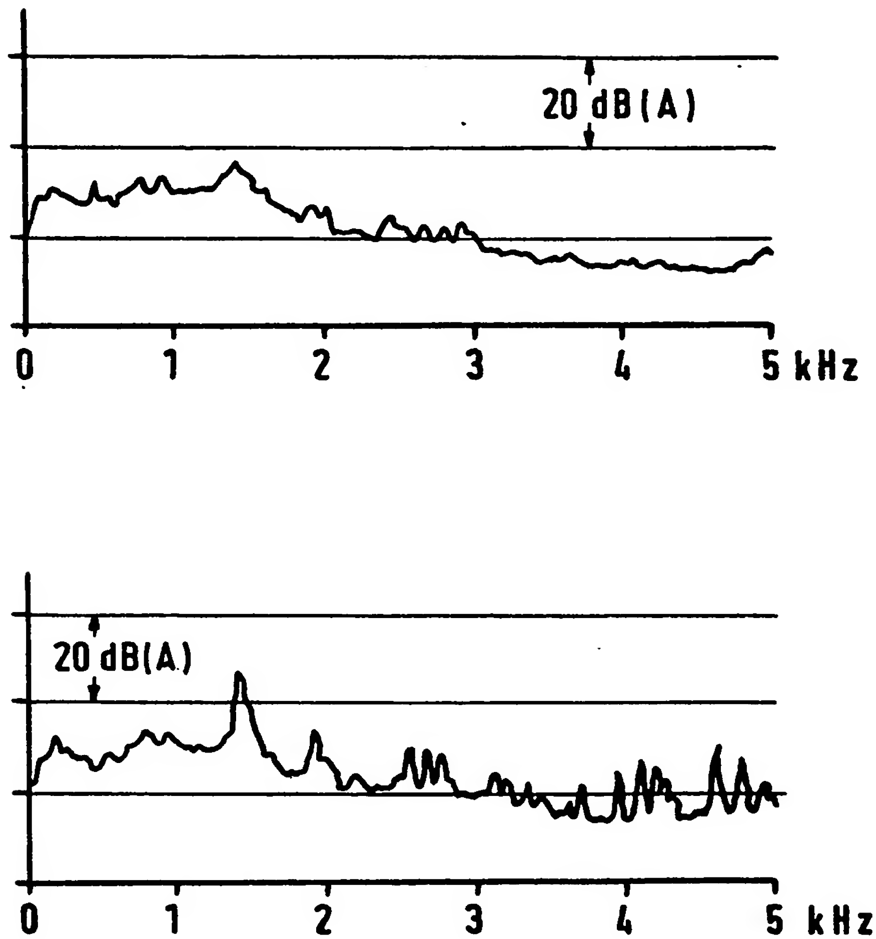


Fig.4



SPECIFICATION

Rail Wheel and Rail System Equipped with Resonance Absorbers

This invention relates to rail wheels and rail systems, in particular such a wheel or system having at least one resonance absorber.

In use alternating ups and downs, so-called ripples, can arise on the running surface of a rail in its longitudinal direction. A wheel running along a rail with ripples produces a noise which increases with the speed of the wheel and which is much greater than that made by a wheel running along a rail free of ripples. For many decades, and not just in recent years where noise has become a significant problem in the protection of the environment, research has been done on the formation and removal of ripples. In addition to the noise nuisance it is also a known problem that the rail sub-structure and the means for fixing the rail to the substructure are under great stress and may be damaged by the vibrations caused by wheels running on a rail with ripples. The vehicle running along a rail with ripples is similarly liable to damage.

Without being able to explain in detail the mechanism of the formation of ripples, it has generally been assumed that ripple formation is connected with oscillations produced in the rail-wheel system.

A number of proposals, only some of which have been tried in practice, have been made for reducing the formation of or removing ripples. Thus, it has been proposed ("Eisenbahningenieur" 27 (1976) pages 200—207) to use a special alloy for the rail material and/or to arrange the rail on a less elastic superstructure. It has further been proposed to make particular changes to the wheel or to the wheel set, e.g. reduction of the unsprung wheel set mass. It has also been proposed (German patent specification no. 966,656, Swiss patent specification no. 321,783) to provide transverse variations e.g. in the form of thickening by the addition of material to the rail at locations distributed at unequal distances along the length of the rail in order to damp the characteristic oscillations of the rail. A further proposal ("ETR" journal (25) 6—1976, pages 381—391 German Offenlegungsschrift 2,616,393) includes the provision of resonance absorbers attached to the wheel rim, the characteristic frequency of the absorbers being tuned to the axial natural bending frequency of the wheel rim reduced or increased by half.

None of these proposals has however provided a satisfactory result. It has still proved necessary occasionally to grind off ripples formed on the rail surface.

According to a first aspect of the present invention there is provided a rail wheel having at least one resonance absorber attached to it at a location spaced from the wheel hub, the or each absorber comprising a mass capable of resonance and damping material and being tuned to the characteristic frequency of the fundamental radial oscillation (as herein defined) of the rail wheel.

According to a second aspect of the present invention there is provided a rail system comprising at least one running rail and a rail wheel adapted to run on the rail, there being at least one resonance absorber attached to the rail, the or each absorber comprising a mass capable of resonance and damping material and being tuned to the characteristic frequency of the fundamental radial oscillation (as herein defined) of the rail wheel.

By "fundamental radial oscillation" is meant the oscillation which has four nodal points on the wheel periphery.

The invention is based on the discovery that it is not the vertical characteristic frequency of the rail which lies in the range of from about 0.9 to 1.2 kHz depending on the rail profile (e.g. in Continental Europe S49 or UIC-60) and the sleeper distance (e.g. approximately 0.6m), which is of predominant significance in ripple formation, but the fundamental radial oscillation (as herein defined) of the wheel running on the rail. In rail wheels used today with a diameter of from about 700 to 1,200 mm the fundamental radial frequency usually lies between 0.9 and 1.5 kHz.

To achieve optimum results with regard to reducing ripple formation resonance absorbers tuned to the characteristic frequency of the rail wheel for its fundamental radial oscillation are preferably distributed along the length of the rail and secured thereto so as to damp oscillations arising on the rail. Although the characteristic frequency of the rail generally deviates from the characteristic frequency of the fundamental radial oscillation of the rail wheel, the latter frequency is imposed upon the rail. An earlier proposal (German patent specification no. 2,657,860) worked from the principle that it was decisive for the reduction of ripple formation to tune the resonance absorbers to the vertical characteristic oscillation of the rail. Ripple formation is greatly reduced with this step, but the results obtained with the present invention can be substantially better with no additional expense.

The resonance absorber preferably has at least one tongue forming said mass capable of resonance and in contact with the damping material, the tongue being fixed at one end to the wheel or the rail and being tuned to the said charactersistic frequency.

The resonance absorber, in addition to the tongue tuned to the characteristic frequency of the rail wheel's fundamental radial oscillation, can include one or more further tongues which are tuned to the characteristic frequency for the screeching and running noises. All of the tongues of the resonance absorber can be formed integrally, one end of each tongue being connected to a common base portion. Alternatively the two tongues of each adjacent pair of tongues can be separated from each other by a spacer plate located between the two tongues at one end thereof. Any pair of two adjacent tongues is preferably separated the

same distance apart as any other pair of adjacent tongues. Each tongue is preferably plate like and has the same breadth and length as its neighbour, but a different thickness. The plate-like tongues are conveniently held equal distances apart by the spacer plates arranged at one end of the tongue.

Where the resonance absorbers are fixed on the wheel, they are preferably attached to a ring secured by heat shrinking on the wheel in a recess between a disc portion of the wheel and a flange or rim portion of the wheel. The ring is conveniently lodged in the recess by heating the wheel and allowing the flange portion to cool and shrink on to the ring. The absorbers can alternatively be secured directly on to the wheel.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, wherein:

Fig. 1 is a lateral view of a rail wheel on a rail;

Fig. 2 shows parts of an axial section of the rail wheel and the rail of Fig. 1.

Fig. 3 shows an isometric representation of a resonance absorber; and

Fig. 4 includes two graphs both of which measure radial oscillations of a wheel along the ordinate against frequency of the oscillation along the abscissa, the upper graph being for a wheel fitted with resonance absorbers.

Referring firstly to Figs. 1 and 2 a track consisting of two rails 1 only one of which is shown) is secured to sleepers 2. The rail includes a foot 3 and a stem portion 14 and has a conventional profile, e.g. S49 or UIC-60. The distance between adjacent sleepers amounts to 0.6 m for example.

A solid rail wheel 5 of a rail vehicle runs on the rail 1. The rail wheel 5 is composed of a hub 6, wheel disc portion 7 and a wheel flange portion 8. The flange portion 8 can be composed of a rim and tyre combination, the tyre being shrunk onto the rim. The illustrated wheel is a rail wheel of the sort which is usually used for railway carriages or tram cars and which is cast or forged from steel and is from 700 to 1,200 mm in diameter.

A truncated conical ring 10 is lodged in a recess 9 which is formed between the wheel disc portion 7 and the wheel flange portion 8 and which slopes slightly conically to the centre plane of the wheel. The ring 10 is inserted into the recess 9 by expanding the wheel 5 by heating and shrink-fitting the wheel 5 on to the ring 10. Resonance absorbers 11 are distributed over the inner periphery of the ring 10 and are secured to the ring 10 by means of screwbolts 12.

Similarly formed resonance absorbers 13 are secured at regular intervals to the underside of the foot 3 of the rail 1 by means of screwbolts 15. Alternatively, or as well as, the resonance absorbers can be secured outside the rail head, e.g. to the side of the rail stem 14 (this possibility is not shown).

Each resonance absorber has at least one plate-shaped tongue, one end of which is fixedly connected to the rail 1 or the wheel 5 so that oscillations of the rail 1 or the wheel 5 can be transferred to the tongue. The tongue embedded in, or contacts on one side, damping material.

Referring now to Fig. 3 a resonance absorber has several plate-shaped tongues 17,18,19,20, which have the same length and breadth as each other, but different thicknesses separated from one another by intermediate layers 21 of damping material. All the tongues 17 to 20 are formed at one end with a common base 22 which has a bore 23 for the screwbolt 12 or 15, which serves as fixing means. The tongues 17 to 20 are made of steel. The damping intermediate layers 21 between individual tongues 17 to 20 are preferably made of silicon rubber.

Whereas the embodiment illustrated in Fig. 3 is produced from a block in which slots have been made to receive the intermediate layers 21, the resonance absorber can alternatively be built up from individual continuous plates which are held apart in the end region corresponding to the base 22 by means of spacer plates.

Although not illustrated a further possibility is the formation of double tongues which share a joint base composed of the centre portions of each double tongue and spacer plates holding the individual tongues apart.

When a rail vehicle runs along the track, the rail wheel is excited and oscillates due to irregularities which are inevitably present even with an as near as possible perfect track surface. A characteristic oscillation of the wheel for ripple formation is the fundamental radial oscillation in which the rail wheel is elliptically distorted. The oscillation lies between 0.9 and 1.5 kHz depending on the construction and diameter of the rail wheel.

As shown in Figs. 1 and 2, the resonance absorbers on the wheel 5 are arranged in such a way that the main oscillation plane is perpendicular to the axis of the wheel and on the rail 1 the resonance absorbers are arranged so that their main plane of oscillation is vertical to correspond to the vertical oscillations of the rail. The resonance absorbers perform best when their plane of oscillation is in alignment with the oscillations of the wheel or the rail, but their effect is still noticeable if they are arranged in a different orientation.

Referring now to Fig. 4 whereas high maxima of the wheel's radial oscillations are present with the undamped wheel not fitted with resonance absorbers (lower graph) a number of these maxima are suppressed with the damped wheel (upper graph). This is particularly marked for the high maximum at 1.4 kHz which corresponds to the fundamental radial oscillation of the wheel under test.

Claims

1. A rail wheel having at least one resonance absorber attached to it at a location spaced from the wheel hub, the or each absorber comprising a mass capable of resonance and damping material and being tuned to the characteristic frequency of

the fundamental radial oscillation (as herein defined) of the rail wheel.

2. A rail system comprising at least one running rail, and a rail wheel adapted to run on the rail, there being at least one resonance absorber attached to the rail, the or each absorber comprising a mass capable of resonance and damping material and being tuned to the characteristic frequency of the fundamental radial oscillation (as herein defined) of the rail wheel.

3. A rail wheel or rail system according to claim 1 or claim 2 wherein the resonance absorber has at least one tongue forming said mass capable of resonance and in contact with the damping material, the tongue being fixed at one end to the wheel or the rail and being tuned to the said characteristic frequency.

4. A rail wheel or rail system according to claim 3 wherein the resonance absorber has one or more tongues tuned to the characteristic frequency of the running and screeching noises of the wheel.

5. A rail wheel or rail system according to claim 4 wherein all of the said tongues of the resonance absorber are formed integrally, one end of each tongue being connected to a common base portion.

6. A rail wheel or rail system according to claim 4 wherein the two tongues of each adjacent pair of tongues are separated from each other by a spacer plate located between the said two tongues at one end thereof.

7. A rail wheel or rail system according to any one of claims 3 to 6 wherein each tongue is plate-like.

8. A rail wheel or rail system according to claim 7 wherein each tongue has the same breadth and length as its neighbour but a different thickness.

9. A rail wheel according to any one of claims 1 and 3 to 8 having a plurality of the resonance absorbers attached to a ring secured by heat-shrinking on the wheel in a recess formed between a disc portion of the wheel and a flange portion of the wheel.

10. A rail system according to any one of claims 2 to 8 having a plurality of said resonance absorbers spaced along its length.

11. A rail system according to claim 10 wherein the rail wheel also has a plurality of the said resonance absorbers attached to it.

12. A rail wheel substantially as herein described with reference to Figs. 1 and 2.

13. A rail system substantially as herein described with reference to Figs. 1 and 2.

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